

UNIVERSITY OF WYOMING
AGRICULTURAL
EXPERIMENT STATION



Power-Duster in Field Near Cody, Wyoming. This Field Yielded 757 Bushels Per Acre.

Sulphur Dusting for the Control of Psyllid
Yellows of Potatoes

Bulletins will be sent free upon request.
Address: Director of Experiment Station, Laramie, Wyoming.

UNIVERSITY OF WYOMING

Agricultural Experiment Station

BOARD OF TRUSTEES

Officers:

RALPH S. LINN.....President	V. J. FACINELLI....Comptroller and Treasurer
HARRIETT T. GRIEVE.....Vice President	FAY E. SMITH.....Secretary

Executive Committee:

PETER SILL	HARRIETT T. GRIEVE	RALPH S. LINN
	VICTOR J. FACINELLI	

Appointed	Members	Term Expires
1925.....	HARRIETT T. GRIEVE.....	1943
1937.....	VICTOR J. FACINELLI.....	1943
1937.....	RALPH S. LINN.....	1943
1939.....	FRANK A. BARRETT.....	1945
1939.....	PETER SILL.....	1945
1939.....	MILWARD L. SIMPSON.....	1945
1941.....	BARD FERRALL.....	1947
1941.....	HAROLD M. JOHNSON.....	1947
1941.....	MARY EDELMAN COPE.....	1947
NELS H. SMITH, Governor of Wyoming.....		Ex Officio
ESTHER L. ANDERSON, State Superintendent of Public Instruction.....		Ex Officio

STATION STAFF

Administration:

J. A. HILL, B.S., Dean of College of Agriculture; Director of Station.
W. L. QUAYLE, B.S., Director Experiment Farms.
MARGARET LAMB, B.S., Station Clerk.

Agronomy and Agricultural Economics:

A. F. VASS, Ph.D., Agronomist.
†GLEN HARTMAN, M.S., Assoc. Agronomist.
T. J. DUNNEWALD, M.S., Assoc. Soil Investigations.
G. H. STARR, Ph.D., Assoc. Agronomist; Plant Pathologist.
W. A. RIEDL, M.S., Asst. Agronomist.
EDWARD J. TALBOT, M.S., Asst. Economist.
DELWIN M. STEVENS, B.S., Asst. Economist.
ROBERT LANG, B.S., Asst. Agronomist.
ROBERT F. ESICK, B.S., Asst. Agronomist.
JOHN F. CYKLER, B.S., Asst. Agronomist.

Animal Production:

FREDRIC S. HULTZ, Ph.D., Animal Husbandman, Beef Cattle, Sheep.
S. S. WHEELER, M.S., Assoc. Animal Husbandman, Swine, Beef Cattle.
H. S. WILLARD, Ph.D., Assoc. Animal Husbandman, Dairy Cattle.
J. A. GORMAN, M.S., Asst. Animal Husbandman, Sheep.
MACK O. NORTH, M.S., Asst. Animal Husbandman, Poultry.

Apiculture and Entomology:

C. H. GILBERT, M.S., Assoc. Research Apiculturist.
*A. P. STURTEVANT, Ph.D., Apiculturist, in Charge U. S. Bee Culture Field Station.
*A. W. WOODROW, Ph.D., Asst. Apiculturist.
*E. C. HOLST, Ph.D., Asst. Bacteriologist.
*J. D. HITCHCOCK, M.A., Junior Apiculturist.

Botany:

AVEN NELSON, Ph.D., Botanist and Horticulturist.

Chemistry:

O. A. BEATH, M.A., Research Chemist.
O. C. MCCREARY, Ph.D., Assoc. Research Chemist.
C. S. GILBERT, M.A., Assoc. Research Chemist.
H. F. EPPSON, M.S., Asst. Chemist.
WILLIAM B. BRADLEY, Ph.D., Asst. Pharmacologist.

Home Economics:

ELIZABETH J. MCKITTRICK, M.S., Home Economics.
EMMA J. THIESSEN, M.A., Asst. Home Economics.

Library:

MARY E. MARKS, Ph.B., Librarian.

Veterinary Science and Bacteriology:

A. M. LEE, D.V.M., M.S., Research Pathologist.
L. H. SCRIVNER, D.V.M., Asst. Veterinarian.
*MARY E. TURNER, Ph.D., Technician.

Weather:

FRANK E. HEPNER, M.S., Head of Weather Station.

Wool:

J. A. HILL, B.S., Wool Specialist.
ROBERT H. BURNS, Ph.D., Wool Specialist.
ALEXANDER JOHNSTON, M.S., Asst. Wool Specialist.

Zoology:

JOHN W. SCOTT, Ph.D., Zoologist and Parasitologist.
†RALPH HONESS, M.A., Asst. Research Zoologist.
HENRY HUIZINGA, M.A., Asst. Research Zoologist.

*In cooperation with U. S. Department of Agriculture.

†On leave.

Sulphur Dusting for the Control of Psyllid Yellows of Potatoes

WILLIAM A. RIEDL

INTRODUCTION

Psyllid yellows is one of the most destructive of known potato diseases and is widely distributed throughout the Rocky Mountain and Western Great Plains states. There is no potato disease known in Wyoming that spreads as rapidly and uniformly or causes the enormous losses that are caused by psyllids during some seasons (2)*. It is estimated that psyllid yellows caused a loss of 50 per cent of the Wyoming potato crop in 1938 (5). Daniels (1) states that this disease cost the potato growers of Colorado \$2,763,200.00 in 1931. The losses caused by this disease vary greatly from year to year and from region to region depending upon the psyllid population.

Even though reasonably satisfactory sprays for the control of the disease have been found, large losses still occur because many growers, especially those who grow potatoes in small fields, cannot afford the expensive spraying equipment which is necessary. The production of potatoes in small garden patches has been impossible during some seasons, because the spraying of small fields is not practical.

In order to find a less expensive, more effective, and more practical method of control the writer conducted trials during the summers of 1939 and 1940 to determine the comparative value of sulphur dust and spray treatments for the control of this disease.

REVIEW OF LITERATURE

The use of dusts for the control of plant diseases is not a new development. According to J. F. Allen, sulphur dust was used in America for the control of powdery mildew of grapes as early as 1848 (4).

*Figures in parentheses refer to "Literature Cited" at the end of this bulletin.

The early investigations with dusts were done with coarse material, and it was doubtless due in a large measure to this factor that so little success was attained. Today dusts with a fineness of at least 98 per cent through a 325 mesh screen are manufactured. The fineness of dust is an important factor. N. C. Young (4) has shown that colloidal sulphur has better fungicidal properties than any other known form. The fineness also increases the adhesiveness and reduces the danger of burning the foliage.

Many new dusts have been developed for the control of insects and plant diseases. Dusting machinery has been vastly improved. Larger fans, more powerful engines, and self-mixing attachments have made dusting more satisfactory. Aeroplanes were used as early as 1921 for dusting. Today large acreages of cotton, potatoes, peanuts, and other crops are dusted by aeroplanes (4).

Numerous additional references on sulphur dusting in general could be cited. However, there are very few on sulphur dusting for the control of psyllids, and only those will be included here.

List (3) states that sulphur dust (300 mesh) was highly effective in controlling psyllids on tomatoes. He also states that lime-sulphur retarded the growth of tomatoes significantly, while no significant retardation was caused in plats treated with sulphur dust. Plats treated with sulphur dust gave higher yields than those treated with lime-sulphur.

Research workers at the New Mexico Experiment Station (6) report that the potato psyllid, formerly controlled by lime-sulphur, is subject to effective and more economical control with sulphur dust.

EXPERIMENTAL RESULTS, 1939

In the 1939 trial conducted on the Agronomy Farm near Laramie, Wyoming, the following treatments were tested on Bliss Triumph potatoes: (1) Lime-sulphur spray with 2 gallons of lime-sulphur to 80 gallons of water per acre; (2) wettable sulphur spray at the rate of 5 pounds of wettable sulphur and 1 gallon of lime-sulphur to 80 gallons of water per acre; (3) sulphur dust (98 per cent through a 325 mesh screen) at the rate of 70 pounds



Figure 1—A Convenient Hand-Duster for Small Garden Patches.

per acre. The lime-sulphur and the wettable sulphur were applied with a four-row sprayer having three nozzles per row, one nozzle on each side of the row spraying upward and one on top of the row spraying down. The spray was applied at a pressure of 300 to 400 pounds per square inch. The sulphur dust was applied to both sides of the row with a rotary hand dust gun, as shown in Figure 1.

The treatments were applied to eight-row plats, 180 feet long, and replicated four times in randomized blocks. The treatments were applied three times during the growing season, on July 17, July 29, and August 16.

Readings on the population of psyllids were made by R. L. Wallis, Assistant Entomologist of the United States Department of Agriculture. Table I shows the number of adults, eggs, and nymphs found. Twenty-five cage samples were used at each plat for adults, and five-leaf samples were used for counts of eggs and nymphs. The plats were examined once a week.

TABLE I
POPULATION OF THE POTATO PSYLLID (*PARATHRIOZA*
COCKERELLI [SULC]) ON FIELD NEAR CONTROL
PLATS, LARAMIE, WYOMING, 1939
LARAMIE

Date	Adults	Eggs	Nymphs	Total
June 22	15	8	3	26
28	7	37	6	50
July 6	3	40	31	74
13	5	5	24	34
20	17	7	12	36
27	92	12	5	109
Aug. 3	149	34	6	189
10	163	55	17	235
17	114	15	14	143
24	88	13	7	108
31	101	20	16	137
Sept. 7	106	42	43	191
14	187	86	81	324
21	147	60	63	270
28	0	11	27	38

While the population of psyllids was not as great in 1939 as it had been in some years in the past, it was greater at Laramie than at any of the other locations in Wyoming and Nebraska where Mr. Wallis made observations.

The field was irrigated three times during the growing season. It should have been irrigated twice more, but this was impossible because of the shortage of irrigation water. This accounts for the low yields.

The potatoes were harvested on September 30, and all potatoes over one-half inch in diameter were picked up and weighed.

Table II shows the average yield for four replications in bushels per acre. The level of significance was calculated for the five per cent point by the analysis of variance method.

TABLE II
THE EFFECT OF SPRAY AND DUST TREATMENTS FOR THE
CONTROL OF PSYLLID YELLOWS ON YIELD
OF POTATOES, AGRONOMY FARM,
LARAMIE, WYOMING, 1939

Treatments	Bushels Per Acre
Untreated	124.4
Lime-sulphur spray	156.6
Wettable sulphur spray	166.2
Sulphur dust	193.7
Level of significance	33.1

All the treatments gave significant or nearly significant increases in yield over untreated plats. Wettable sulphur yielded more than lime-sulphur, but the difference between the two was not significant. Sulphur dust yielded significantly more than lime-sulphur and almost significantly more than wettable sulphur.

EXPERIMENTAL RESULTS, 1940

In view of the fact that sulphur dust gave better results for the control of psyllid yellows than lime-sulphur in 1939, it was decided to test this material again on a larger scale in 1940.

Laramie Trial.

In the trial conducted on the Agronomy Farm, the following materials were tested: (1) Lime-sulphur at the rate of $2\frac{1}{2}$ gallons to 80 gallons of water per acre; (2) wettable sulphur at the rate of 8 pounds to 80 gallons of water per acre; (3) sulphur dust (98 per cent through a 325 mesh screen) at an average rate of 35 pounds per acre.

The concentration of the lime-sulphur solution was increased over that used in the 1939 trial because it was felt that the 1:40 solution did not give satisfactory control. No lime-sulphur was mixed with the wettable sulphur, because a different brand of wettable sulphur was used this year. The brand used in the 1939 trial was too expensive for commercial use. The rate of sulphur dust was reduced 50 per cent because it was felt that the dust was applied too heavily in the 1939 trial.

The treatments were applied in the same manner as in 1939, except that four- instead of eight-row plats were used. The dates of application were July 25, August 13, and August 26, an average of 11 days later than in the previous year.

Readings on the psyllid population were again made by Mr. Wallis. This year the readings were made on two replications of the control plats, four times during the season, on August 23 and 30, and September 6 and 13.

Mr. Wallis reported finding a greater population of psyllids at Laramie than at any other place where he made readings in Wyoming and Nebraska. The readings are shown in Table III.

TABLE III
POPULATION OF THE POTATO PSYLLID (*PARATHRIOZA*
COCKERELLI [SULC]) ON CONTROL PLATS,
LARAMIE, WYOMING, 1940
(Average of 4 readings on 2 replications)

Treatments	Adults	Eggs	Nymphs	Total
Untreated	35.0	44.4	39.1	118.5
Lime-sulphur	17.8	27.4	16.0	61.2
Wettable sulphur	23.9	40.6	27.5	92.0
Sulphur dust	14.6	24.0	20.0	58.6

Sulphur dust gave the best control of the adults and eggs, although the lime-sulphur gave better control of the nymphs. Probably the reason that sulphur dust did not give better control of the nymphs is that the application of dust was not heavy enough or that the treatment was applied too late.

The field was irrigated once before planting and four times after planting. The potatoes were harvested on October 8 and 9. All tubers over one-half inch in diameter were picked up, and the potatoes from each row were weighed and stored separately. During the first week in December, the potatoes were sorted over a $1\frac{7}{8}$ -inch screen, and the weights of U. S. Number Ones were obtained for each plat.

The level of significance was calculated for the five per cent point by the analysis of variance method.

Table IV shows the average total yield and the yield of U. S. Number Ones in bushels per acre for each treatment.

TABLE IV
THE EFFECT OF SPRAY AND DUST TREATMENTS FOR THE
CONTROL OF PSYLLID YELLOWS ON YIELD
OF POTATOES, AGRONOMY FARM,
LARAMIE, WYOMING, 1940

Treatments	Total Bu. per Acre	Bu. of U. S. No. Ones per Acre
Untreated	159.8	77.7
Lime-sulphur spray	280.7	185.5
Wettable sulphur spray	233.0	138.2
Sulphur dust	254.7	157.7
Level of significance	29.7	32.1

All the treatments gave significant increases in yield over the untreated plats, both of all potatoes and of U. S. Number One potatoes. Lime-sulphur gave significantly higher yields than wettable sulphur, but not significantly higher yields than sulphur dust.

The fact that sulphur dust did not prove as satisfactory in comparison to lime-sulphur as it did in the 1939 trials may be explained by the fact that the lime-sulphur concentration was increased and the rate of dust was decreased. It may also be explained by the fact that the treatments were applied later in 1940. Sulphur dust is more effective when applied while the nymphs are in the early stages.

Field Trials

In order to test the comparative value of dust and spray treatments on a larger scale, a power duster was obtained which applied the dust from both sides of the row. Figure 2 shows the power duster in operation, and Figure 3 is a close-up to show position of the discharge pipes. Experiments were set up in farmers' fields at six locations in the state. Five experiments were on irrigated fields in Goshen County, and one on a dry land field in Ni-



Figure 2—Two-Row Power Duster, Equipped with a Canvas Hood,
Used in the Field Trials.

obrara County. The first application of the treatments was made August 2 to 7. The psyllid population was so low in these areas that only two irrigated fields near Lingle were sprayed and dusted the second time. Complete yield data were obtained from only those fields which received two applications of the treatments.

George Wunder Field. The same treatments as in the Laramie trial were applied in eight-row plats, 600 feet long, replicated four times in randomized blocks. All of the potatoes from two center rows of each plat were harvested and weighed on October 2. The average yield per acre for each treatment is shown in Table V.

While the psyllid population was low in this field, sulphur dust gave the highest yields. It was closely followed by lime-sulphur and wettable sulphur. The differences between the different treatments were not significant, indicating that it does not pay to spray or dust when the psyllid population is very low.

George Tapster Field. The treatments were applied in the same manner as in the George Wunder field. This field had a considerably higher psyllid population than the field mentioned above.



Figure 3—Two-Row Power Duster with Hood Raised to Show the Discharge Pipes.

TABLE V
THE EFFECT OF SPRAY AND DUST TREATMENTS FOR THE
CONTROL OF PSYLLID YELLOWS ON YIELD OF
POTATOES, GEORGE WUNDER FIELD,
LINGLE, WYOMING, 1940

Treatments	Bu. per Acre	Rank
Untreated	212.8	4
Lime-sulphur	228.2	2
Wettable sulphur	218.0	3
Sulphur dust	231.4	1
Level of significance	25.2	

Ten-hill samples from a part of the field having a uniform stand were selected from each of two center rows in each eight-row plat. A good hill was selected first, and then every second hill was dug until all ten hills were harvested. The total weight and the weight of U. S. Number One potatoes were obtained. The results are shown in bushels per acre in Table VI.

TABLE VI
THE EFFECT OF SPRAY AND DUST TREATMENTS FOR THE
CONTROL OF PSYLLID YELLOWS ON YIELD OF
POTATOES, GEORGE TAPSTER FIELD,
LINGLE, WYOMING, 1940

Treatments	Total Bu. per Acre	Bu. U. S. No. Ones per Acre	Rank
Untreated	220.5	169.5	4
Lime-sulphur	266.6	226.9	2
Wettable sulphur	252.0	225.4	3
Sulphur dust	340.1	317.6	1
Level of significance..	55.2	75.0	

Sulphur dust gave significant increases in total yield and in yield of U. S. Number Ones over all of the other treatments, but these results cannot be considered as reliable as those obtained in experiments where the entire plats or entire rows in the plats were harvested. However, the grower did harvest the entire plats later and stated that he obtained the same trend of results as was obtained by the sample method.

Demonstrational Trials

Sulphur dust was furnished to six potato growers near Laramie. They applied the dust with a hand dust gun twice during the growing season. While the first application was made late, most of the growers reported that sulphur dust increased yields and that the potatoes produced on the untreated plats were much smaller. One grower reported that dust increased the yield 62 bushels per acre, and that dusting the rows on both sides gave 13 bushels higher yield than dusting the vines on one side only.

ADVANTAGES AND DISADVANTAGES OF DUSTING IN COMPARISON TO SPRAYING

Dusting has certain advantages over spraying which are as follows:

1. The investment in equipment is much less. A good sprayer costs between \$600.00 and \$1,000.00, while a good power duster can be obtained from \$150.00 to \$300.00. A hand dust gun, suitable for dusting small fields, can be obtained for less than \$10.00.

2. Less time is required for the application of dust than for sprays, because more rows can be treated at one time and no time is required for refilling with water, as is the case in spraying. Therefore, more timely applications can be made.

3. Less labor is required for dusting. One man can run a duster, while it usually takes two or three men for a sprayer.

4. No water is required for dusting. The use of water is a large item of expense in some cases.

5. Less motive power is required for dusting.

6. Dusts are less caustic than liquid sprays (4).

7. More chemicals can be mixed in a dust form than in a liquid form. This is advantageous for the control of other diseases and insects with the same application.

8. Dusting equipment is much lighter and can more readily be drawn through wet fields.

9. The hand-duster is less troublesome than a hand-sprayer.

The disadvantages of dusting are as follows:

1. Dusting materials are more expensive than spray materials (but the cost of dusting per acre may even be less than for spraying, as the cost of equipment is less).

2. Dusts cannot be applied while the wind is blowing hard. (However, with the use of a hood, dust can be applied when there is considerable wind).

SUMMARY

Two years' results with the use of sulphur dust for the control of psyllid yellows of potatoes show that plats treated with sulphur dust gave significant increases in yield over untreated plats in all cases where the population of psyllids was high.

Sulphur dust when used at the rate of 70 pounds per acre gave significant increases in yield over lime-sulphur, while plats treated with sulphur dust at the rate of 35 pounds per acre were not significantly lower in yield than plats treated with lime-sulphur.

The most desirable rate of applying sulphur dust has not been determined. However, 40 to 50 pounds per acre applied at the right time should give satisfactory control of potato psyllids.

Plats sprayed with wettable sulphur yielded less than plats sprayed with lime-sulphur. Wettable sulphur has no particular advantage over lime-sulphur and is more troublesome to apply, as it causes frequent plugging of the nozzles.

These results indicate that it is advisable to dust small fields of potatoes where spraying is not practical. Dusting may also be advisable where the cost of hauling water is great or where the grower feels he cannot make the necessary investment for good spraying equipment.

It is felt that more large-scale testing is necessary to determine if dusting with sulphur is more economical than spraying with lime-sulphur for the control of psyllid yellows in large fields.

LITERATURE CITED

1. Daniels, Leslie B. Controlling Colorado potato pests. Colo. Agri. Exp. Sta. Bul. 437. 1937.
2. Hartman, Glen. A study of psyllid yellows in Wyoming. Wyo. Agri. Exp. Sta. Bul. 220. 1937.
3. List, George M. The potato and tomato psyllid and its control on tomatoes. Colo. Agri. Exp. Sta. Bul. 454. 1939.
4. Mason, A. Freeman. Spraying, dusting and fumigating of plants: 7-8; 204-209. 1936. The McMillan Co.
5. Starr, G. H. U. S. Dept. Agri. Bur. Plant Ind. Plant Disease Report. Dec., 1939.
6. Whitley, F. F. Potato psyllid control. Ext. Ent. 4; No. 5 Dec., 1940.

ACKNOWLEDGMENTS

The writer wishes to acknowledge the cooperation of the following in conducting these trials:

The Freeport Sulphur Company for furnishing the spray and dust materials.

Glen Hartman for beginning the work on sulphur dusting at this station.

R. L. Wallis, Assistant Entomologist of the U. S. Department of Agriculture, for making psyllid population counts.

George Tapster and George Wunder for furnishing the commercial fields for the trials and for their assistance in harvesting.

Paul Dupertuis for spraying the plats in the field trials.

The State Department of Agriculture for furnishing the power-duster used in the field trials.

The following publications of the Wyoming Experiment Station may be had upon request: (Revised list, January, 1941).

ANNUAL REPORTS—

19th to 50th, inclusive (1908-9 to 1939-40, inclusive, except 21st and 22nd.)

INDEX BULLETINS—

E, G, and H.

No. STATE FARMS BULLETINS—

1. Spring Wheat Production in Eastern Wyoming.
2. Winter Wheat Production in Eastern Wyoming.

No. CIRCULARS—

16. The Effect of Alkali on Portland Cement.

No. BULLETINS—

112. The Poisonous Properties of the Two-Grooved Milk Vetch (*Astragalus bisulcatus*.)
116. Winter Grains.
163. Results with Tree Planting at the Sheridan Field Station.
185. Barley Tests at the Sheridan Field Station.
192. Growing Trees in Northeastern Wyoming.
205. Economic Studies of Irrigated Farms in Big Horn County.
209. Forty Years of Weather Records.
212. Steer Feeding in Southeastern Wyoming.
214. Bacterial Wilt of Alfalfa.
216. Sugar Beet By-Products for Fattening Lambs.
218. Cultural Methods for Winter Wheat on Non-Irrigated Lands in Northeastern Wyoming.
219. Progress Report of the State Experiment Farms.
220. Study of Psyllid Yellows in Wyoming.
221. Occurrence of Selenium and Seleniferous Vegetation in Wyoming.
222. Potato Seed-Treatment Studies in Wyoming 1932-36.
223. Corn Production on the Campbell County Experiment Farm.
224. Spring Wheat Production and Varieties for Wyoming.
225. Variations in the Shrinkage of Wyoming Wools.
226. Field Experiments on Bunt of Wheat.
227. Sugar Beet Tops, Cottonseed Cake and Mono-Calcium Phosphate in Rations for Steers.
228. Type of Farming and Ranching Areas in Wyoming.
229. Vegetative Composition, Density, Carrying Capacity and Grazing Land Values in the Red Desert Area.
230. Feeding Systems for Laying Hens.
231. Poisonous Plants and Livestock Poisoning.
232. Breastbones of Turkeys.
233. Phosphorus in Wyoming Pasture, Hay, and Other Feeds.
234. Cellar Wintering of Bees.
235. Deep Fat Frying at High Altitudes.
237. Roughage Feeding of Dairy Cattle.
238. Wintering Bees in Wyoming.
239. The Two-Queen Hive and Commercial Honey Production.
240. Salinity Conditions in the Big Horn River During the Years 1938 and 1939.
241. Livestock Poisoning by Oat Hay and Other Plants Containing Nitrate.
242. Making White and Whole Wheat Bread with Three Types of Yeast and Hard Wheat Flour.
243. Practical Results from the State Experiment Farms.
244. Bacterial Ring-Rot of Potatoes.